Observations of biomass burning plumes in the stratosphere during CRYSTAL-FACE

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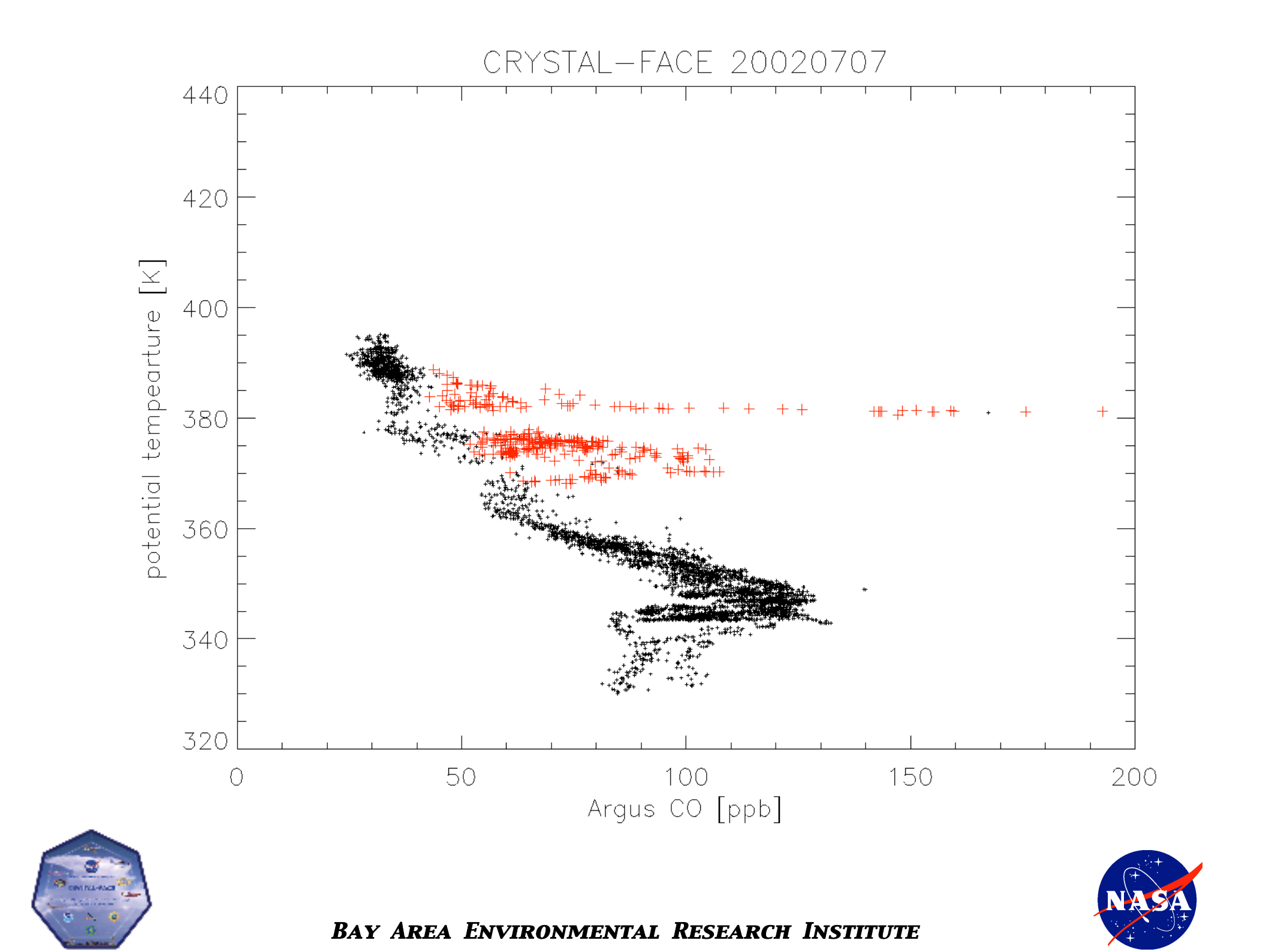
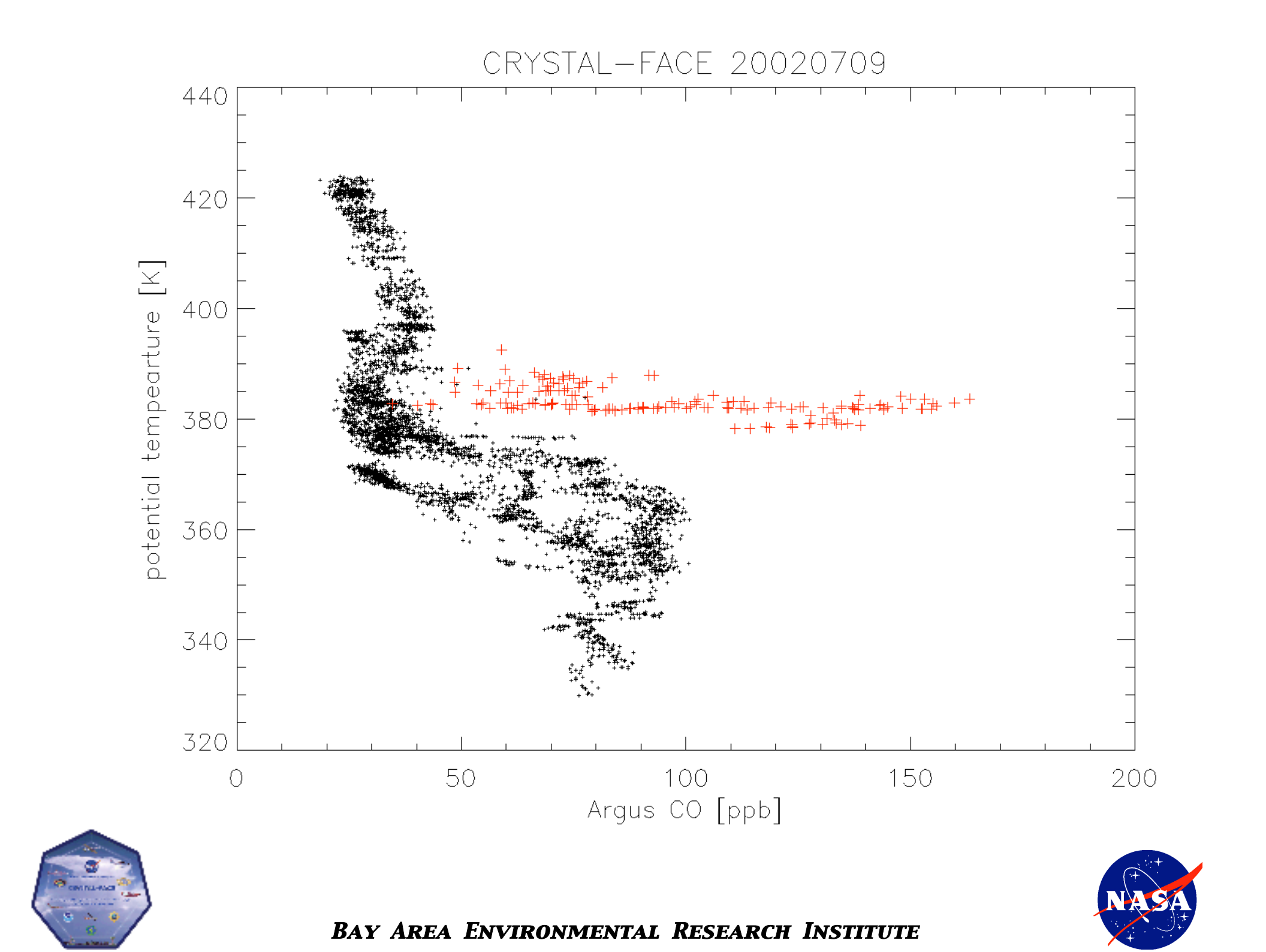

CRYSTAL–FACE 20020707
potential tempearture [K]
440
420
400
380
360
340
320
0
50
100
150
200
Argus CO [ppb]



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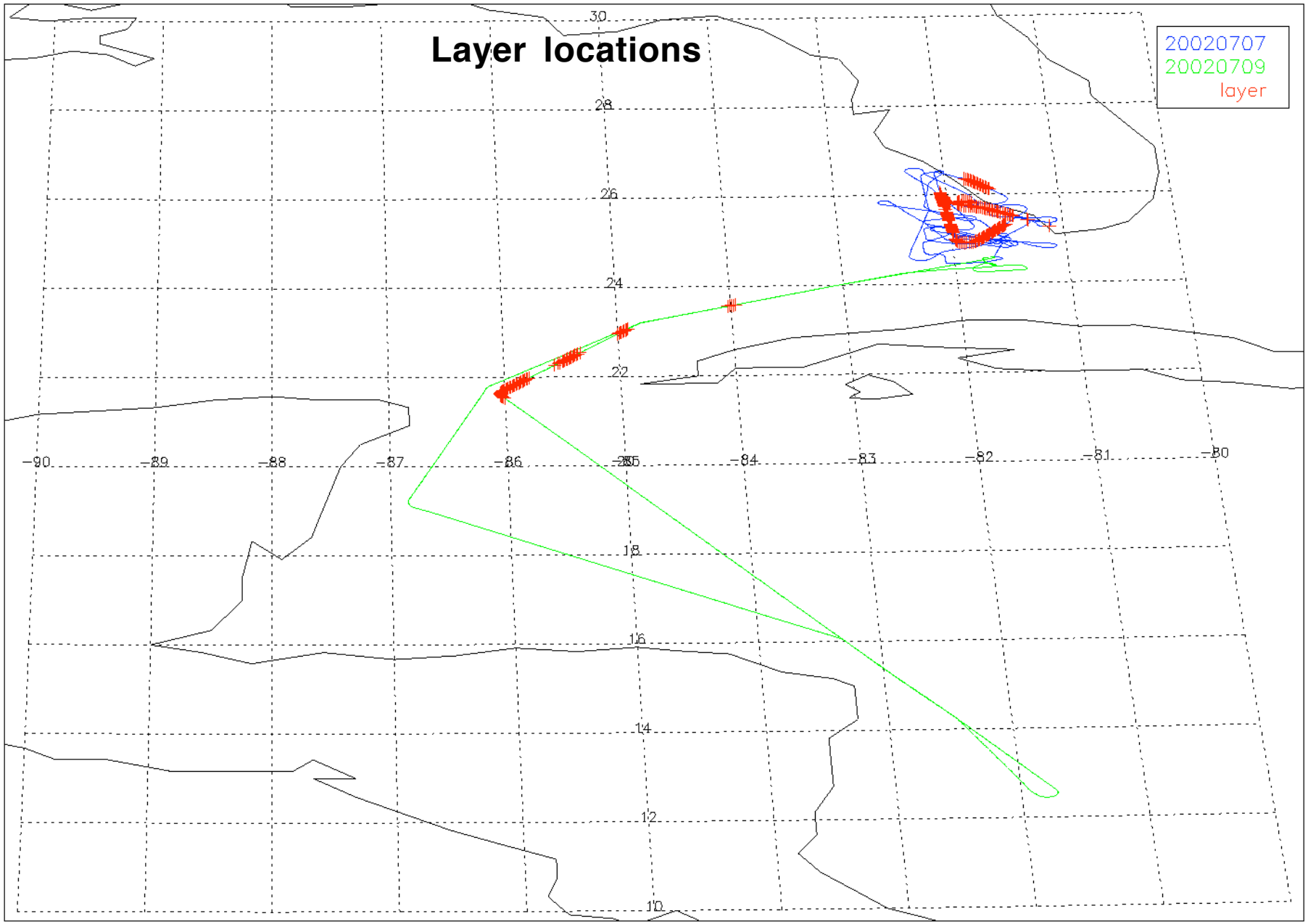
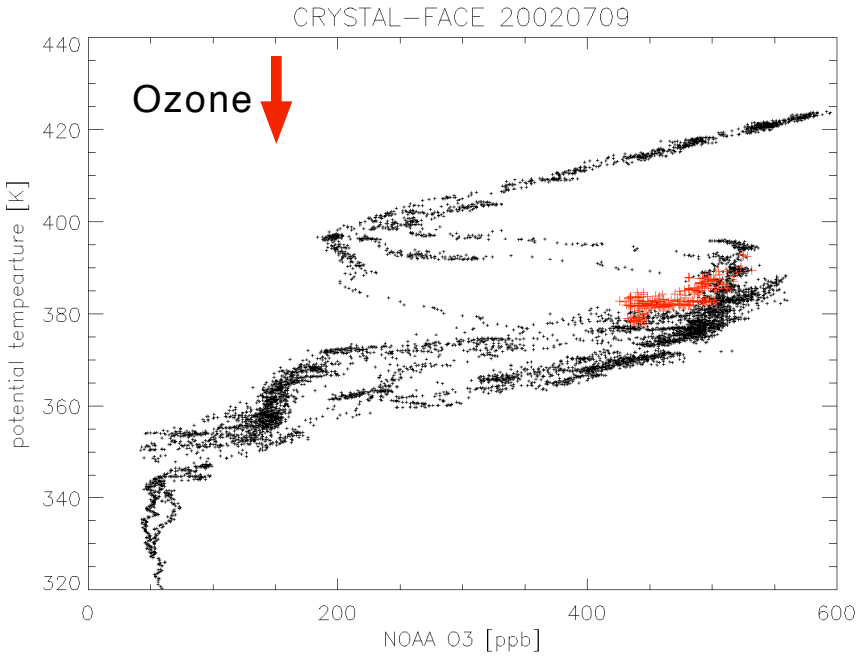
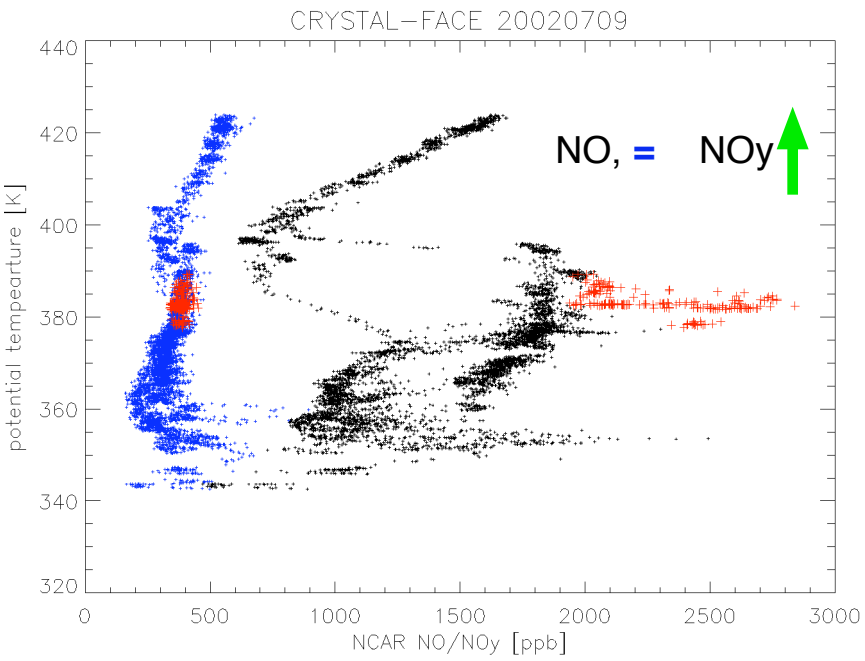
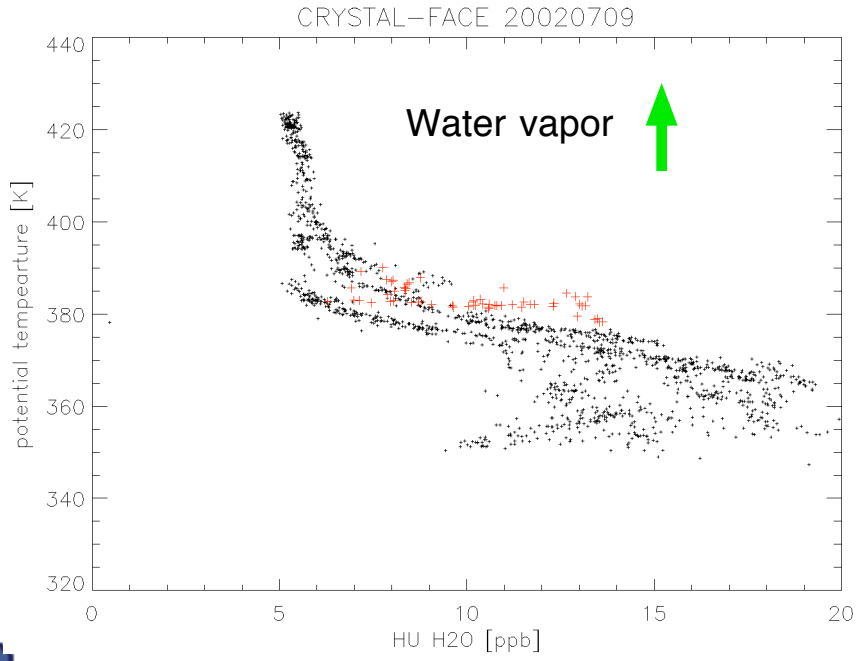
Layer locations

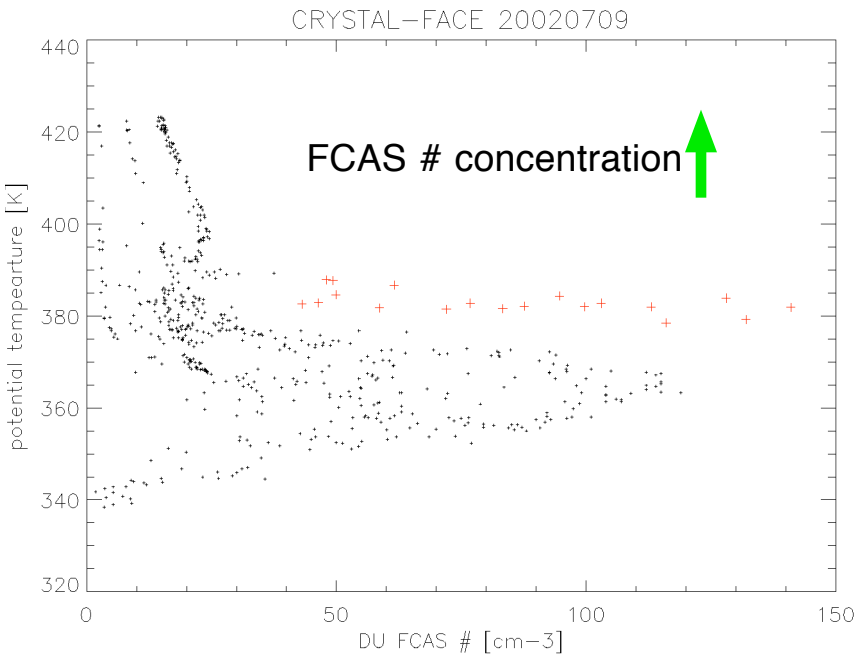


Other measurements



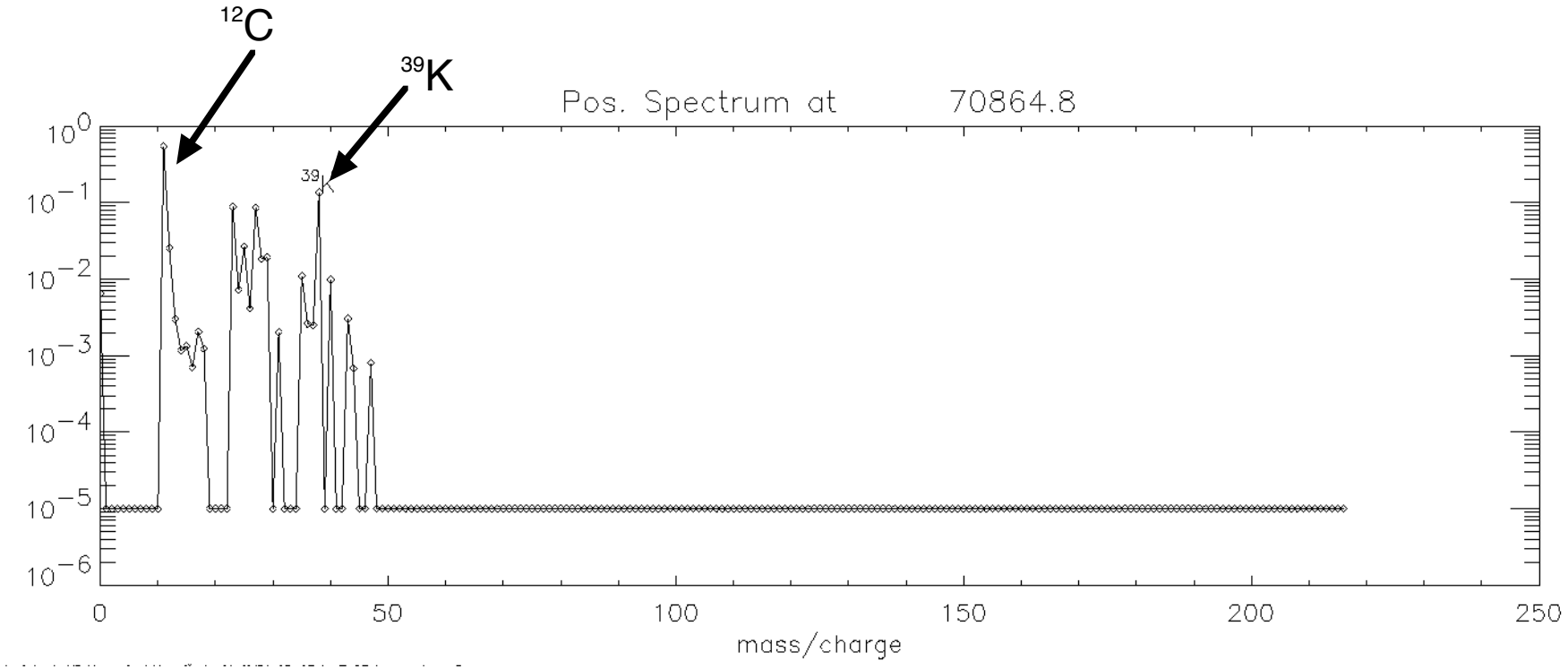




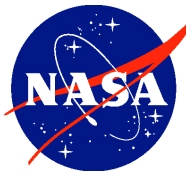


CO_2

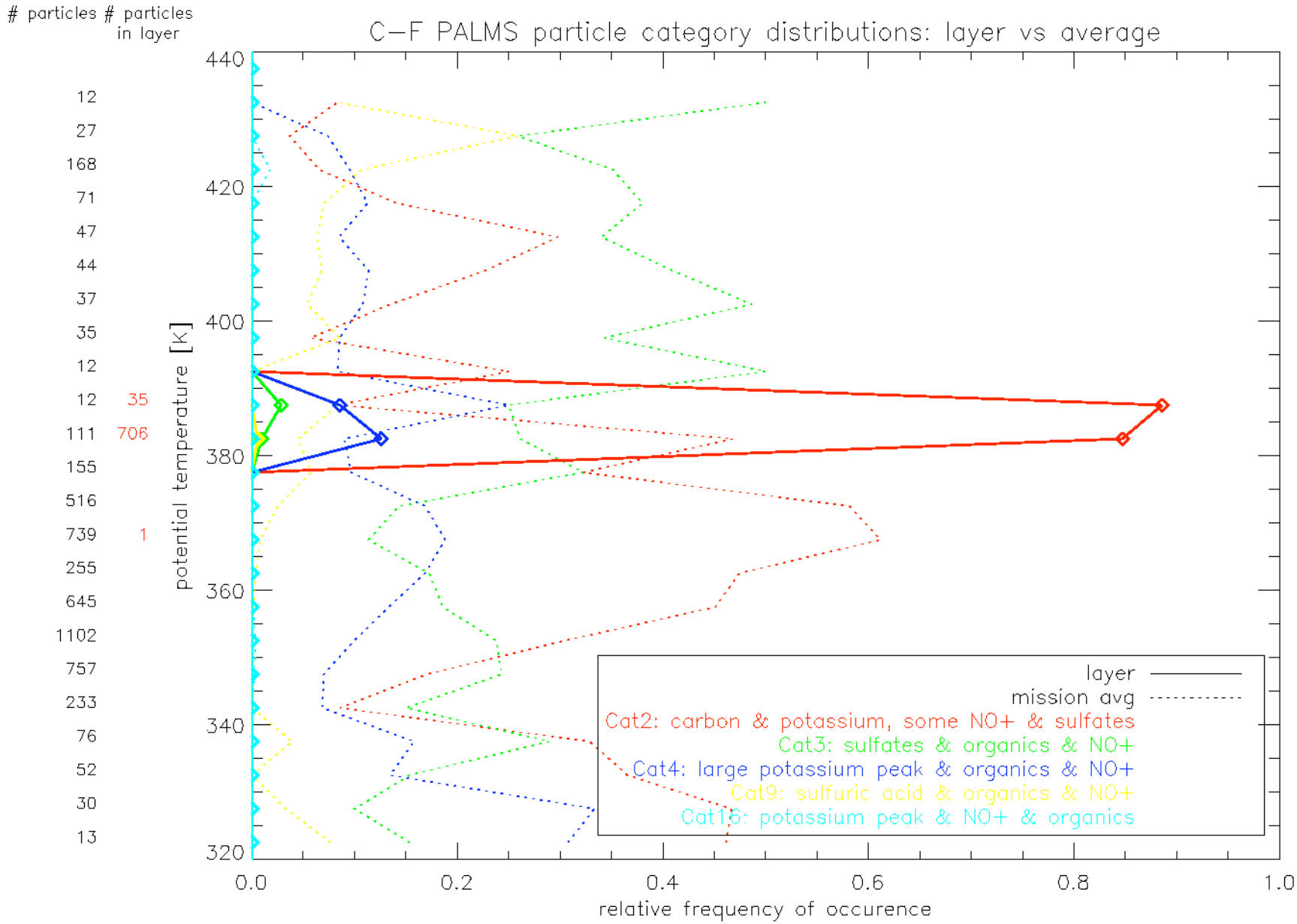
PALMS single particle spectrum



- signature of carbon and potassium is typical for biomass burning plume particles
- automatic characterization



PALMS particle categories distribution



Black Carbon Estimate

background:	2 □m^3/cm^3
in layer:	3.2 □m^3/cm^3
BC mass in layer :	6 ng/cm^3

Volume of 500km x 500km x 1km:	1.5 Gg
Compare to:	
total stratospheric BC [Pueschell, 92]	2.0 Gg
Global annual aircraft BC emission: [IPCC]	0.5 Gg

Black Carbon Estimate

background:	2 □m^3/cm^3
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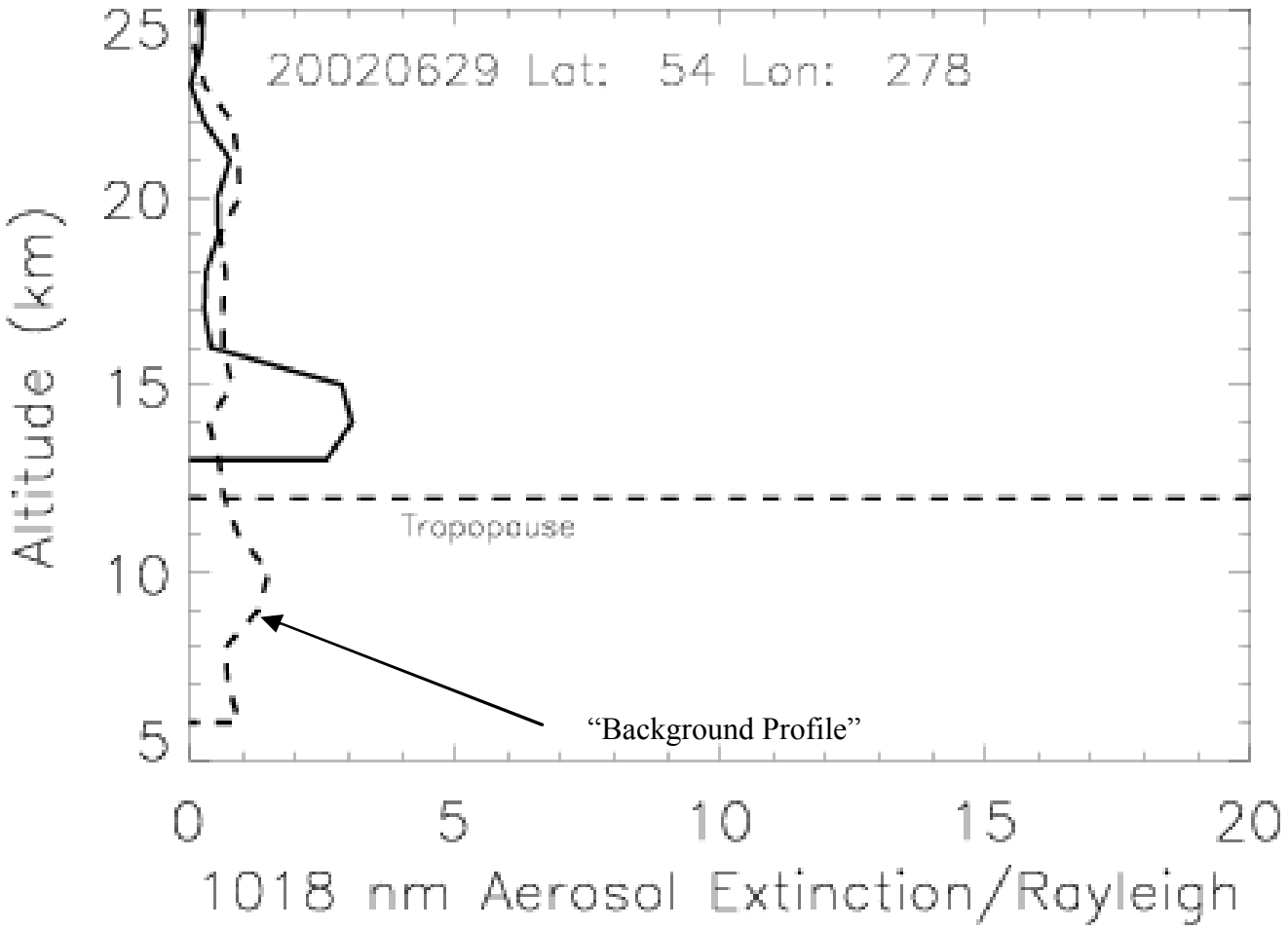
BC mass in layer :	6 ng/cm^3

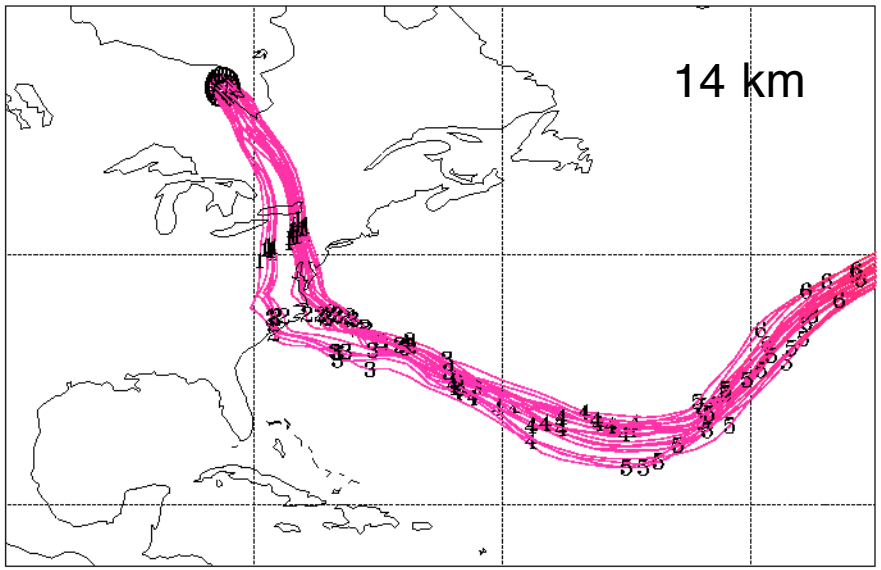
Volume of 500km x 500km x 1km:	1.5 Gg
Compare to:	
total stratospheric BC [Pueschell, 92]	2.0 Gg
Global annual aircraft BC emission: [IPCC]	0.5 Gg

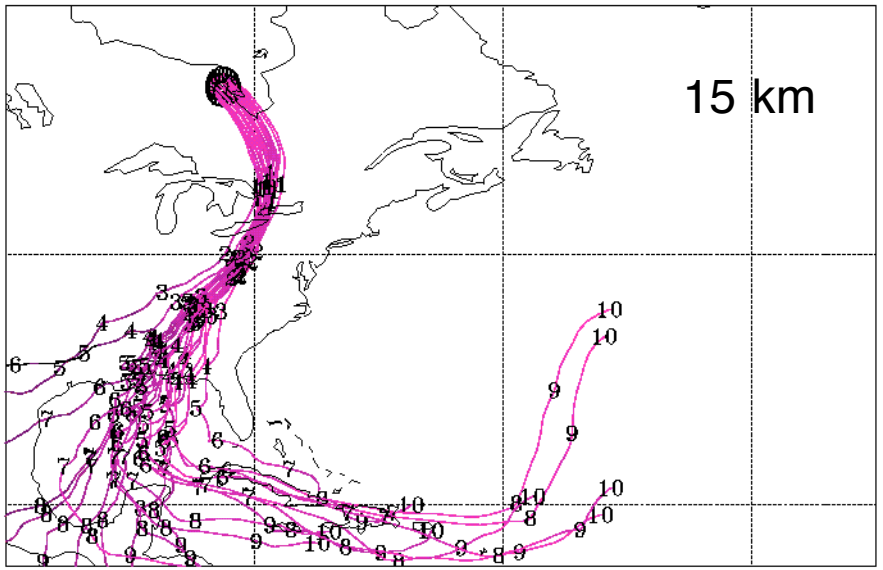
input of other short lived species into the stratosphere!

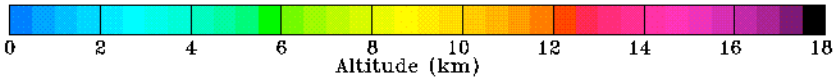
POAM III Plume encounter

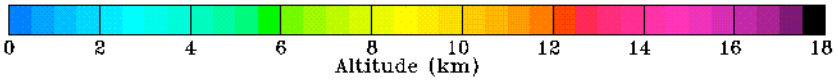


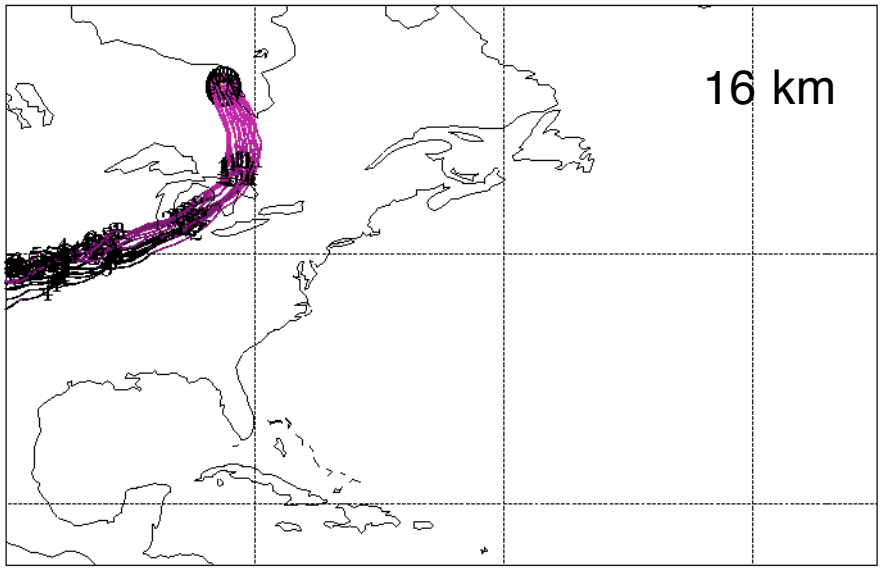
POAM III 3-D forward trajectories

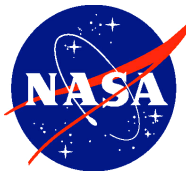










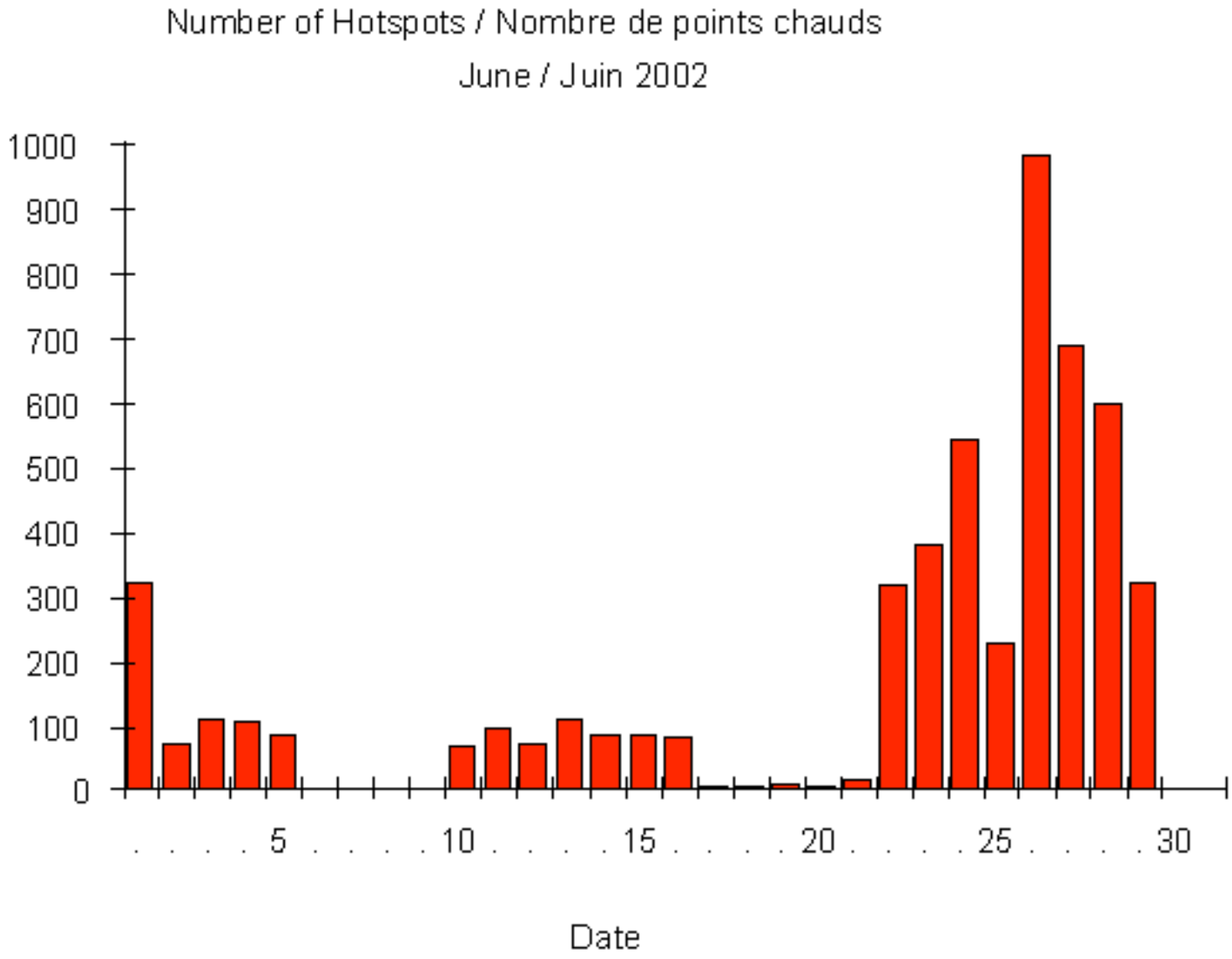


FLEXPART model description

- Lagrangian Transport Model
- Advection and turbulent diffusion treated by calculating multitude of particles
- Stochasitc fluctuations obtained by solving Langevin equations superimposed on ECMWF or AVN fields
- Subgrid scale convective transport by convective scheme [Emanuel and Zikovic-Rothman]
- CO emission data:
  - Fire information from US and Canadian forest services
  - EDGAR v3.2 inventory
- Total CO column agrees well with TOMS aerosol product

More information:

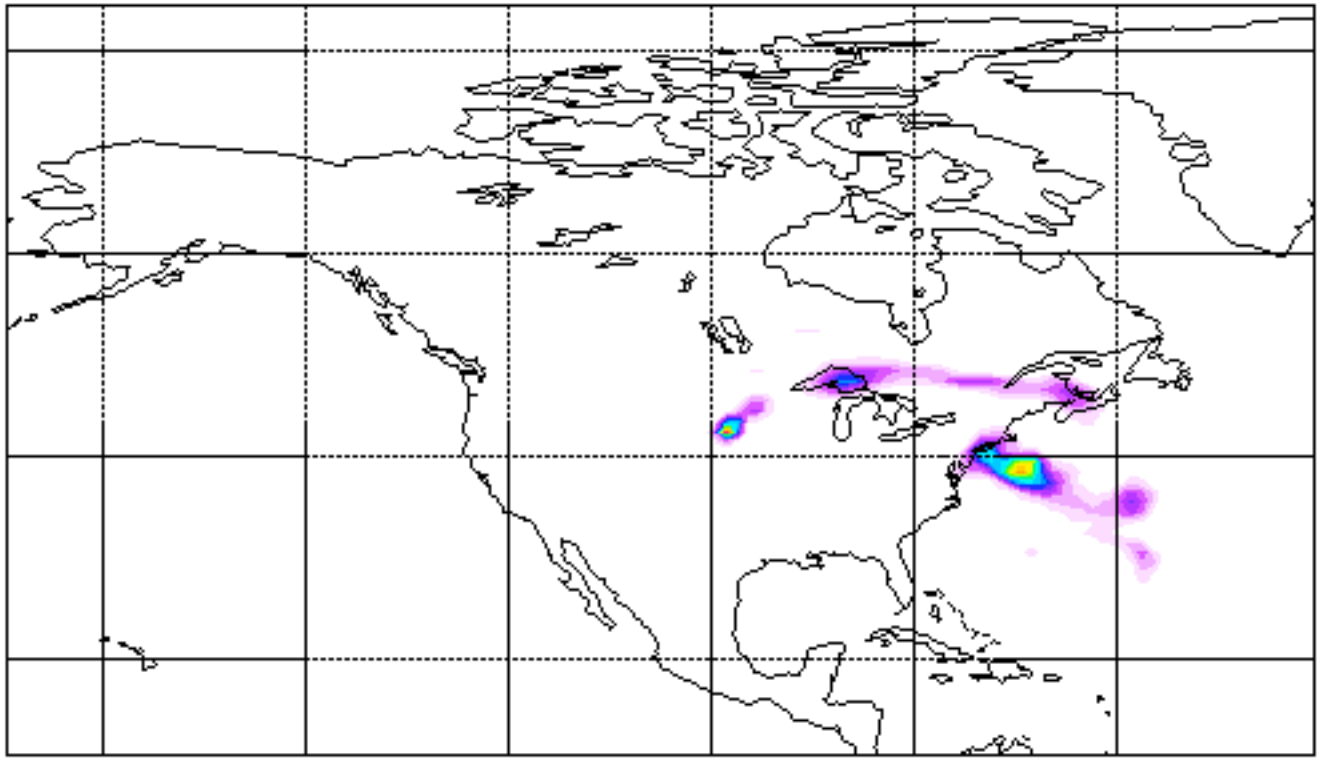
http://www.forst.tu-muenchen.de/EXT/LST/METEO/stohl/

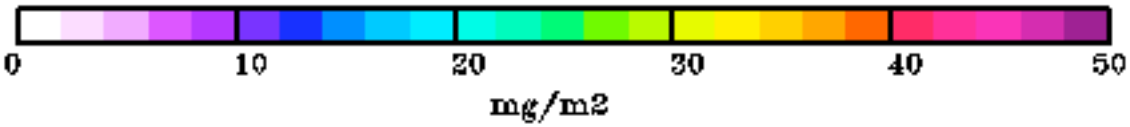

Number of Hotspots / Nombre de points chauds
June / Juin 2002
1000
900
800
700
600
500
400
300
200
100
0
5
10
15
20
25
30
Date

FLEXPART: CO column from US fires in layer 12-17km

Poster
Max Loewenstein
O_3:CO relationship

Total column of species 1 for age class all
Simulation start: 20020620. 0 Actual time: 20020624. 0
Mean value: 0.140E+00
Maximum value: 0.422E+02
Minimum value: 0.000E+00

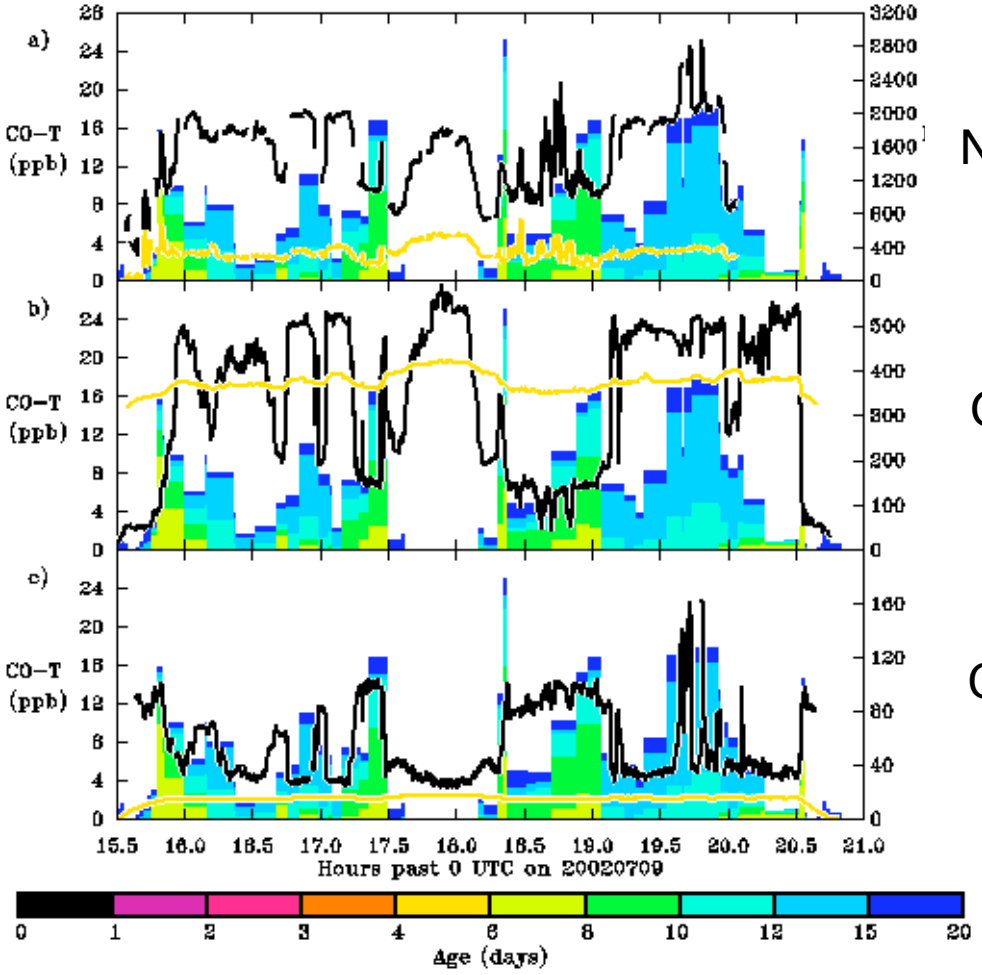




FLEXPART model results for 20020709 flightpath

US contributions

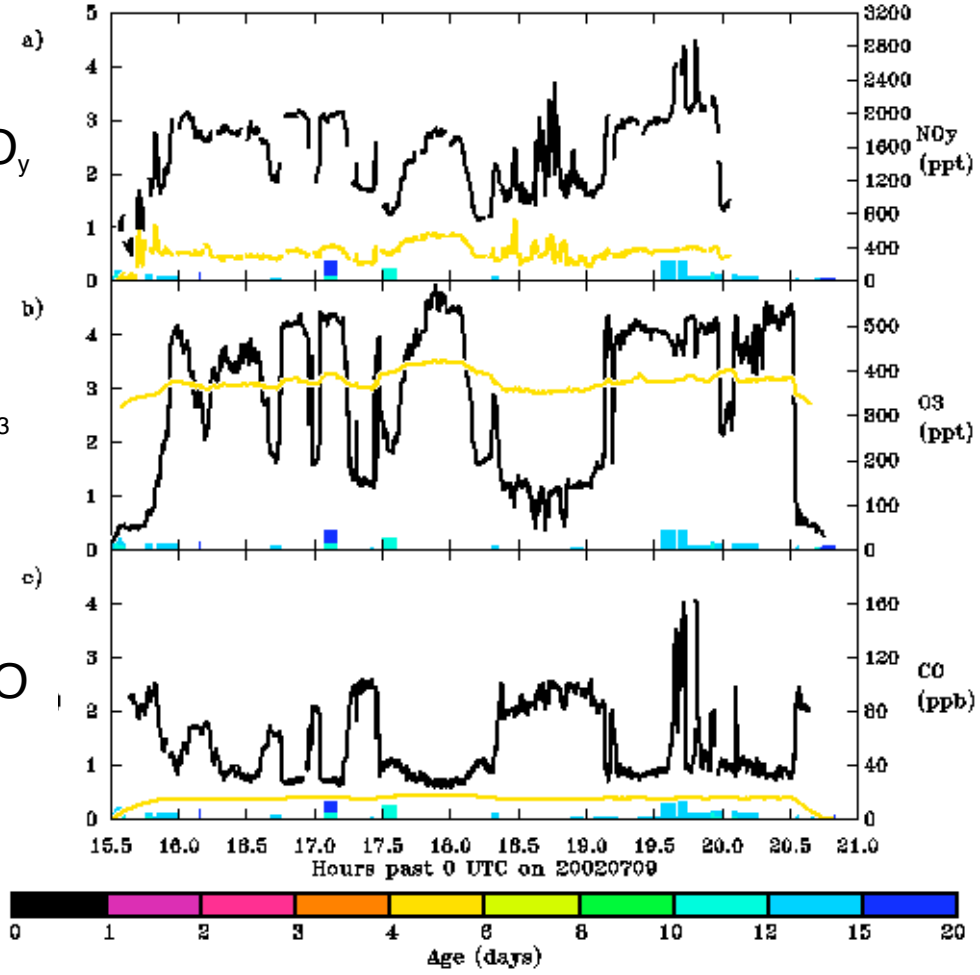
Canadian contributions



NO_y

O_3

CO



Note: different y axis!

Plume self heating and lofting

Calculated optical depth @ 550 nm = 0.025
Reflected Solar Radiation (upward Forcing) = 0.55 Wm-2

average heating rate due to absorption by BC = 0.21 K/day

Initial Assumptions:

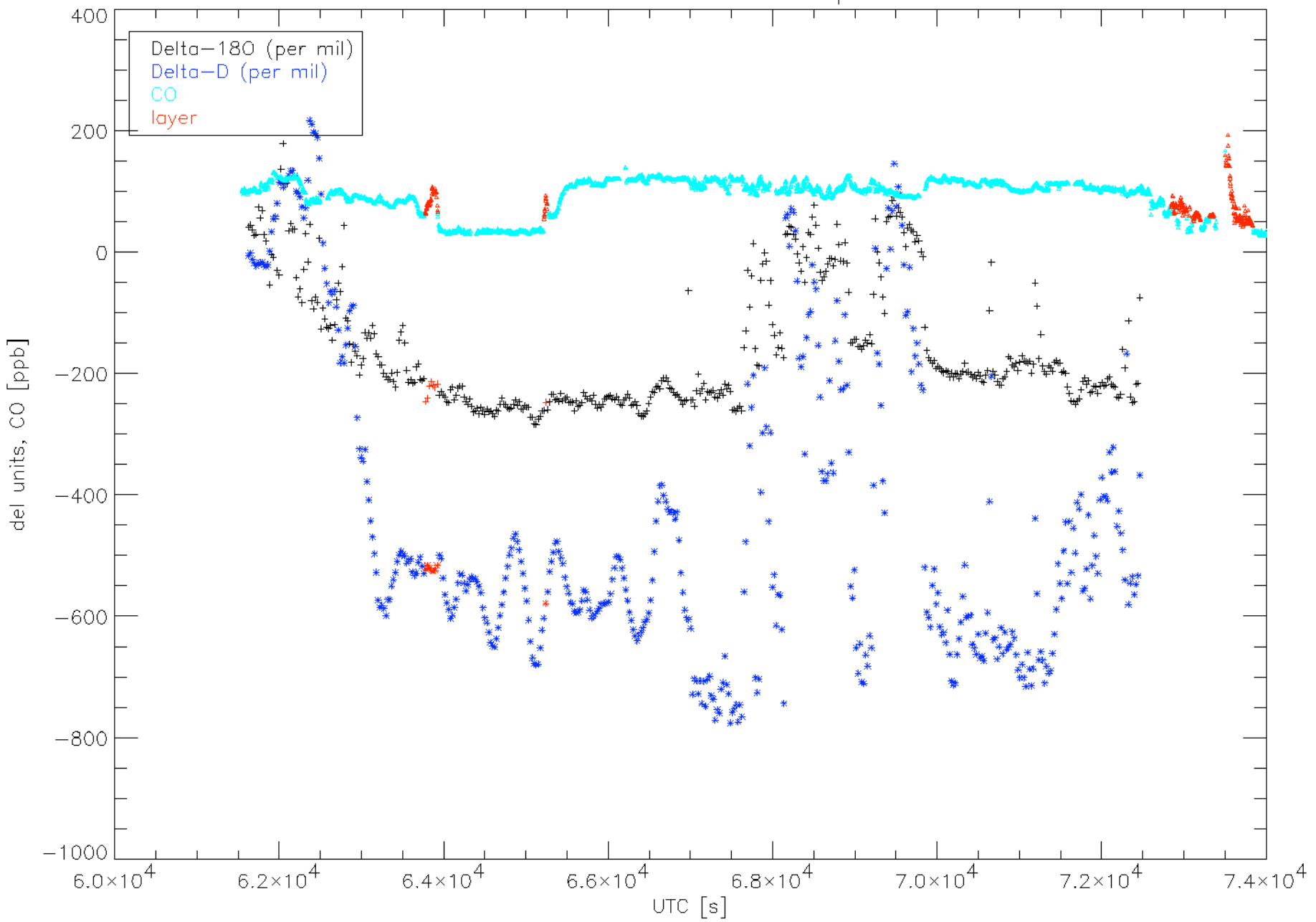
- Spherical Particles
- log normal size distribution (r_{eff} = 0.1 um)
- Mixture of BC and non-absorbing particles
- single scatter albedo = 0.9
- 12 hours sunlight per day

Conclusions

- Large scale convective systems can pump boundary layer air into overworld at mid-latitude
- It stays there
- Helped by or triggered by fires
- Source for substantial amount of BC
- Other trace species injected

Next steps

- Use LIDAR and satellite data to pin down size of plume
- Look at particle size distributions and what they mean, compare fall velocities with radiative updraft
- Convective system pumping up to POAM not yet identified
- More radiative impacts
- Write paper...



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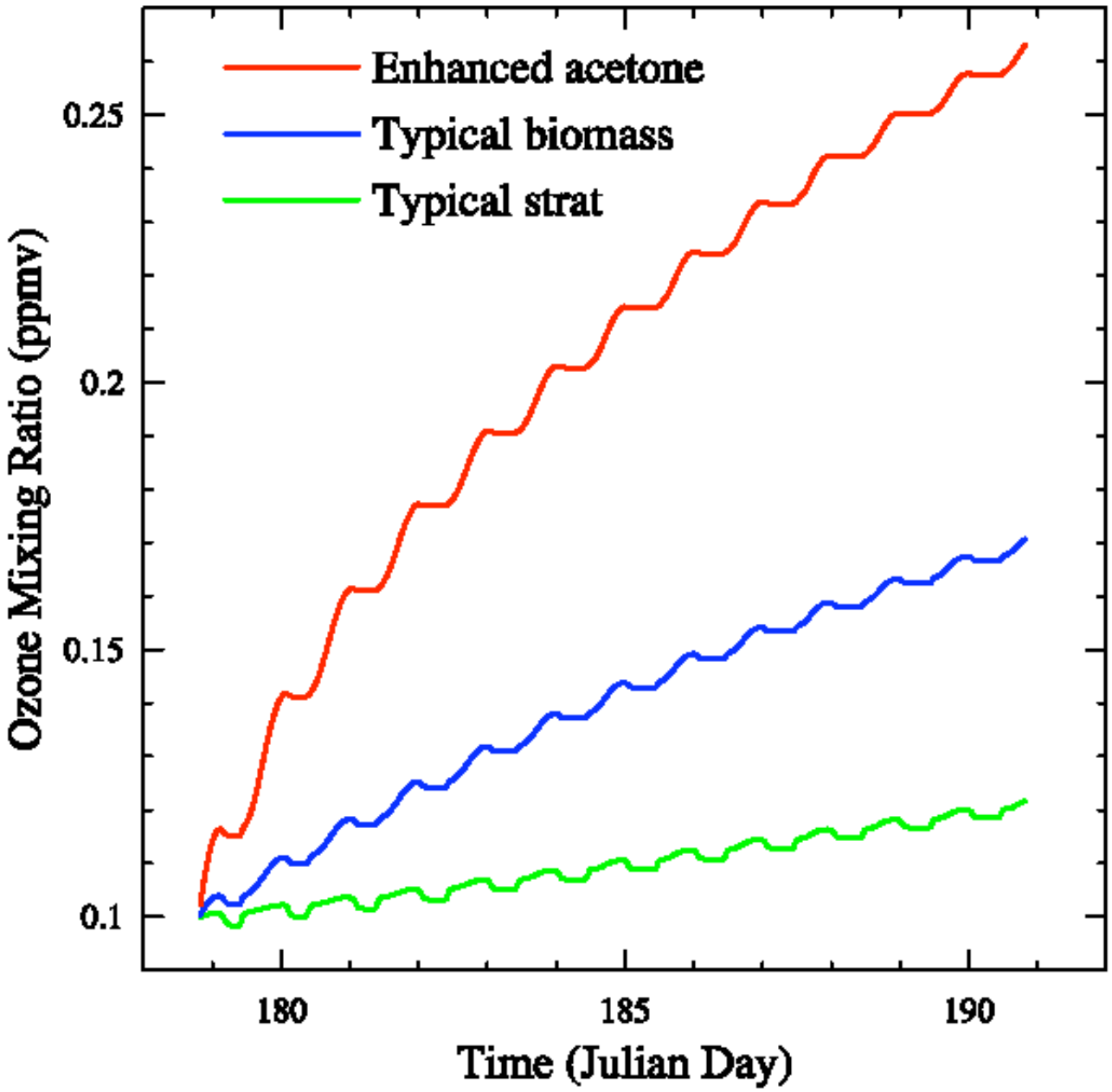
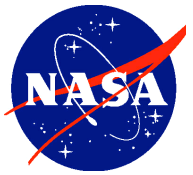
Modelled Ozone Evolution




NASA